EDGE of Existence and phylogenetic diversity

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The EDGE of Existence program provides a flagship example about how to address some key challenges in biodiversity conservation. EDGE is global, and inter-generational, in recognising that conservation of phylogenetic diversity globally maintains options for future generations. The program also is necessarily local, in integrating global priorities with locally led conservation initiatives and capacity-building. EDGE spans the full scope of “biodiversity” in another way – moving beyond the usual charismatic species, it tells us why we should care about species that otherwise might be forgotten.

As a bold program for biodiversity, EDGE of Existence must also embrace fundamental uncertainties. It focuses on the value of maintaining variety given that we do not know about future benefits of individual species, but also embraces challenges in quantifying that variety, given inevitable gaps in knowledge about species and their phylogenetic relationships.

Weedop et al. (2019) provide some useful further investigation of the “missing” species problem (see also Gumbs et al. 2018). My commentary will not explore their detailed findings, but it will draw out possible wider implications. The EDGE metric is based explicitly on the biodiversity measure, “phylogenetic diversity” (PD; Faith 1992; Isaac et al., 2007), and an understanding of this foundation can usefully fill-in some gaps in the Weedop et al. study, and point to some wider perspectives.

Terminological and other confusions have created a challenge for communicating PD conservation (reviewed in Faith 2018; Owen et al. 2018). Weedop et al. provide background on EDGE and ED but provide no citation for “phylogenetic diversity”. Clarification is useful given that their study is from an “sDiv” phylogeny/conservation working group that has used the term “phylogenetic diversity” to refer to many different metrics.

In the Weedop et al. study, we can infer that “phylogenetic diversity” indeed has the standard meaning of Faith (1992), noting that ED scores were designed to divide-up total phylogenetic diversity (PD) among species. We also can recognise that phrases like “decisions to preserve biodiversity—including evolutionary history”, would be clearer if they referred to the actual biodiversity measure, PD (which is based on, but not equivalent to, phylogeny or evolutionary history).

Beyond clarifications of terms, the role of phylogenetic diversity in EDGE highlights wider perspectives, under three themes – “the value of phylogenetic diversity”; “PD calculations beyond ED”; and “phylogenetic risk analysis”.

The value of phylogenetic diversity
“Biodiversity” refers to living variation (at multiple levels). Even before the coining of the term, conservationists recognised that the loss of such variety matters because it means a loss of options for future generations. Phylogenetic diversity (PD; Faith 1992) measures the total evolutionary history represented by a set of species; it also is a biodiversity measure because it indicates variety or feature diversity (the range of different evolutionary features; see Faith 2017; 2018).

EDGE of Existence not only uses PD mathematically, but also recognises PD “option value” (see Faith 2018; Owen et al. 2018). EDGE information helped the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) use PD as an indicator of “maintenance of options”. IPBES also estimated expected loss of PD globally, for major taxonomic groups (reviewed in Faith et al. 2018).

Awareness of the values of PD, and unprecedented expected PD losses, has catalysed an IUCN SSC Phylogenetic Diversity Task Force, which will communicate PD to conservation practitioners, decision-makers, and the public.

The assessments and conservation programs above are regional/global scale, and so highlight the importance of addressing missing species globally. The value of phylogenetic diversity also influences our risk-aversion in dealing with the uncertainties of missing species.

**PD calculations beyond ED**

Because PD is a measure of biodiversity at the level of features, many associated calculations operate as if working directly with features (e.g. endemism or dissimilarity). Within the broad mission to conserve PD, the decision-maker can choose among a range of PD-derived indices, supporting decision-making. ED is one example of a PD-derived index. This “PD calculus” is a flexible, coherent, framework. It largely overcomes the perception (e.g. in the sDiv working group) that there is a confusing jungle of measures of evolutionary history, with PD as just another measure, alongside ED and other indices.

The PD calculus provides alternatives to ED that can overcome its documented weaknesses (reviewed in Faith et al. 2018). For an endangered species, x, suppose we have secure sister species, y, and both are at the end of a long branch. The high ED value for x might be robust, but in reality the high ED score does not capture the fact that the long branch is secure, and x is not a priority. Weedop et al. do not refer to this issue, but it seems reasonable to ask – should we focus on robustness of ED values, if true ED values can be misleading?

EDGE is now refining its approach (EDGE of Existence 2017) to use an alternative part of the PD calculus: “expected PD” (reviewed in Faith 2008; Faith et al. 2018). Future work should focus on how unknown phylogenetic position and/or unknown conservation status influence estimates of expected PD loss.

**Phylogenetic risk analysis**

Phylogenetic risk analysis (Faith 2008) may be useful for these investigations. It adopts ideas about risk aversion to look at worst-case PD losses. While Weedop et al.’s assessment of ED
robustness looked at average behaviour over all species, for expected PD loss, we may focus on threatened species. An estimated low expected PD loss calculated for a given threatened species will not increase by later adding-in missing species. However, a current estimated high expected PD loss for a threatened species can decrease after adding-in missing species. Here, phylogenetic risk analysis offers two core options. A conservative approach may give priority only to relatively “bullet-proof” cases of high expected PD loss (there are few missing species in that clade and/or the missing species also are threatened). Alternatively, an aversion to risk of worst-case outcomes might recognise priority, ignoring scenarios about missing species. This is compelling – after all, “extinction is forever” means the loss, forever, of phylogenetic diversity and its benefits to society.

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References


